

Analyzing AQP Data to Improve Electronic Flight Bag (EFB) Operations and Training

Thomas Seamster
Cognitive & Human Factors

Barbara Kanki
NASA Ames Research Center

Presentation Outline

Using AQP in an EFB Implementation

- EFB authorization process
- EFB authorization and AQP
- AQP Small Group Tryout
- Instructor/Evaluator training and standardization
- Use of data to pinpoint areas for improvements
- Value of longitudinal data collection and analysis.

EFB Authorization Process

EFB authorization includes five phases:

- Phase One: Initiation (2 to 10 weeks)
- **Phase Two: Application (8 to 16 weeks)**
- Phase Three: Principal Inspector (PI) Review (4-8 weeks)
- Phase Four: Interim Authorization to Use an EFB (possibly several years)
- Phase Five: Authorization to Use an EFB (4-8 weeks).

EFB Authorization Process: Phase Two

Estimated Timeline	Operator Activity/Product	Notes
Phase One: Initiation		
1st week	Finalize STC, TC and authorization responsibilities with EFB suppliers and installers	(see Order 8900.1, Vol. 4, Ch. 15, Figure 4-75)
2nd week	Develop EFB Implementation Timeline, form EFB team and complete EFB Tabletop Evaluation	(see Order 8900.1, Vol. 4, Ch. 15, Figure 4-79)
3rd week	Operator internal meeting with engineering, standards, training, AQP , dispatch and maintenance	Specify timeline activities and products
4th week	Review procedures and documents to identify EFB additions/changes	Identify ACO , AEG , and AQP requirements
5th week	Prepare and conduct internal review of Request for Authorization and Outline Formal EFB Plan	Include pilot groups
6th week	Submit Request for Authorization & Outline Formal EFB Plan negotiating any changes with PI	Specify ACO , AEG and AQP contacts
Phase Two: Application		
8th week	Complete and submit Formal EFB Plan to PI and start procedures, documents and training revisions	Check Appendix A-F of this Guide
9th week	Prepare Draft EFB related documents (AFM/FOM/MEL /checklist) additions/changes	See Table 2
10th week	Negotiate final agreement with PI on Formal EFB Plan with any changes in writing	Clarify any changes to Formal EFB Plan
11th week	Complete Draft EFB pilot/instructor training lessons and crew assessment procedures	See Table 4
12th week	Complete Small Group Trial of EFB procedures, training and performance/proficiency (this may be optional but advisable, especially for an AQP fleet)	Involve PI and pilot groups in trial
13th week	Prepare EFB Evaluation Report	See Appendix D
14th week	Assemble and review EFB Application Package	Include pilot groups
16th week	Submit EFB Application Package to PI and Small Group Trial results to AQP (if an AQP fleet)	
Phase Three: PI Review		
18th week	Install EFB training devices (classrooms and/or simulator) and train I/Es	Ensure that I/Es use standard assessment
19th week	Negotiate any changes to the EFB Application Package with PI	
20th week	Review EFB procedures, documents and training packages	Include PI and pilot groups
21st week	Ensure EFB data collection is comprehensive and ready for implementation	See Table 4
Phase Four: Interim Authorization		
22nd week	Implement data collection for the EFB Validation Final Report	See Appendix F
24th week	Evaluate and refine data collection for the EFB Validation Final Report	Include PI and pilot groups
8 months or more from start	Prepare, review and submit EFB Validation Final Report to PI	
Phase Five: Authorization		
9 months or more from start	Ensure authorization for use is placed in OpSpec A025	
10 months or more from start	Monitor and report ongoing EFB crew performance/proficiency and EFB reliability, and analyze to refine procedures/training.	



Phase Two Operator Steps	
Step 2.1	Use Outline Formal EFB Plan prepared in Phase One to complete the Formal EFB Plan and submit it to the PI agreeing on a date when the PI will render a decision.
Step 2.2	While the Formal EFB Plan is being reviewed by the PI, start work on the changes to Existing Operating Documents : <ul style="list-style-type: none"> AFM and FOM, initially released as a bulletin, providing conditions, limitations, philosophy and procedures for the use of the EFB Checklists to include EFB checking, startup and shutdown Flight Training Manual including description of EFB system components, functionalities, differences, and usage under a variety of operational conditions for all flight phases MEL including the EFB system in accordance with the MMEL General Maintenance Manual including on-going maintenance and inspection of EFB equipment. <p>NOTE: Use the checklist in Table 3 to further identify all documents and sections that might require new or revised EFB information.</p>
Step 2.3	Review Formal EFB Plan with PI and obtain a written agreement of the Plan's acceptance along with any required changes.
Step 2.4	Work with EFB supplier(s) to gather all required documents specified in the Formal EFB Plan pertaining to EFB: Crashworthiness, Rapid decompression and Non-interference.
Step 2.5	Review results from Step 1.3 (EFB Tabletop Evaluation) and finalize EFB procedures and training to address any unresolved issues.
Step 2.6	Finalize changes to Existing Operating Documents and have pilots review the EFB system completing Items 1-91 from Checklist 2, EFB Operational Evaluation (see Order 8900.1, Vol. 4, Ch. 15, Figure 4-80).
Step 2.7	Use Items 92-107 in Checklist 2, EFB Operational Evaluation (see Order 8900.1, Vol. 4, Ch. 15, Figure 4-80), to develop an EFB Line Oriented Evaluation (LOE) and conduct a small group trial if possible at this time. A small group trial may be performed using EFBs installed in a simulator with 4-8 crews flying the LOE. If a small group trial is possible, use its results to complete Checklist 2 – EFB Operational Evaluation, Items 92-109. NOTE: If a small group trial is not possible during Phase Two, specify which form of EFB Operational Evaluation will be conducted by Phase Four.
Step 2.8	Prepare the EFB Evaluation Report which at a minimum includes a cover page and the completed Checklist 1 (see Step 1.1) and Checklist 2 (see Step 2.6) with supporting data. The cover page should provide an explanation of items that were marked as No in either Checklist 1 or 2 (e.g., the item is not applicable, or the item will be addressed by Phase Four, etc.). See Appendix D for sample outline.
Step 2.9	Review the EFB Application Package for completeness using the checklist in Table 3 and then submit it to the PI.

Phase Two: Application

Phase Two includes:

- Existing Operating Documents: Make changes required for EFB implementation
- EFB Supplier Documents: Obtain required tests
- EFB Procedures & Training: Modify using EFB Tabletop evaluation results
- **Small Group Tryout: Collect data and prepare EFB Evaluation Report**
- EFB Application Package: Complete and submit.

EFB Evaluation Report

The EFB Evaluation Report requires the evaluation of the EFB system including:

- EFB Hardware
- General User Interface
- Software Applications
- **EFB Procedures**
- **EFB Training**
- **Crew Performance (main phases of flight).**

EFB Training and Performance

Two sections of the EFB Evaluation Report require data on:

- Suitability of Normal Procedures
- Suitability of Non-Normal Procedures
- EFB Software Applications Training
- Crew Workload
- Currency for Proficiency.

EFB Evaluation & AQP Small Group Tryout

Small Group Tryout (SGT) for EFB based on AQP guidance includes:

- Prepare training and LOS materials
- Train Instructors and Evaluators (I/Es)
- Conduct approved curriculum
- Analyze and submit performance/proficiency data
- Revise EFB training program.

EFB and Line Operational Simulations



Analyzing AQP Data to Improve EFB Operations and Training, June 2, 2010

Train I/Es: LOS Administration

For this example we will consider a LOS with the following Event Sets:

- Event Set 1: Preflight with several deferrals
- Event Set 2: Push back with Generator Fail
- Event Set 3: Climb with clearance change
- Event Set 4: Hold and airport shut down
- Event Set 5: Reroute with fuel considerations.

Train I/Es: LOS Administration

LOFT Event Set 1

Conditions

- APU GENERATOR AND LEFT CLEARVIEW WINDOW DEFOG DEFERRED
- RELEASED VFR WEATHER
- UNUSUAL DEPARTURE WITH RESTRICTIONS
- TRWs ENROUTE

Trigger

- Receipt of PDC changes SID from Orlando 8 to Jaguar 3

Event Set 1 Start: Receipt of PDC			Time:	
Event Set 1 Stop: Crew updates FMS and completes cross-check using navigation publications.			Time:	
	Superior = 4	Good = 3	Problem = 2	Repeat = 1
CAPT use of FMS and navigational pubs to conduct brief				
FO setup and use of navigation pubs up to and through brief				

Train I/Es: Performance Assessment

The eight I/Es in this example all viewed the same video of an average crew flying the LOS and after each event set were given several minutes to individually:

- Note the start and stop time for each Event Set
- Rate each Event Set independently
- Write comments about the LOS administration, simulator problems and any other issues.

Train I/Es: Performance Assessment

Data was collected from all eight I/Es for the 18 Captain and F/O behaviors being rated on the following four-point scale:

- 4 = Superior (substantially above standard)
- 3 = Good (standard crew performance)
- 2 = Problem (problem that was resolved during LOS)
- 1 = Repeat (one or more problems not resolved)

Train I/Es: Data Analysis

Of the numerous methods for Inter-Rater Reliability (IRR) analysis, consider:

- **Systematic Differences:** Analysis of each I/E's ratings compared to the group using a ***t* test** to identify those who are significantly different (**$< .05$**) from the group.
- **Agreement:** Analysis of each behavior being rated using the **r_{wg}** formula, and reviewing behaviors with a relatively low agreement with an **r_{wg}** less than **.5**.

Train I/Es: Systematic Differences

EFB I/E Check	I/E-1	I/E-2	I/E-3	I/E-4	I/E-5	I/E-6	I/E-7	I/E-8
ES1-CAPT FMS & Brief	4	3	3	4	3	2	4	3
ES1-FO FMS & Support Brief	4	3	2	3	2	1	3	3
ES2-CAPT MEL	4	4	3	4	3	3	3	3
ES2-CAPT Decision	4	3	2	3	2	2	3	3
ES2-FO MEL	3	2	2	2	1	3	2	2
ES2-FO Support	3	3	1	2	1	3	2	2
ES3-CAPT ID J85	3	3	2	1	2	2	3	2
ES3-FO ID J85	4	3	2	2	2	3	3	3
ES3-CAPT FMS	4	3	2	3	2	3	3	3
ES3-FO FMS	4	4	2	3	2	3	3	3
ES4-CAPT FMS	4	3	2	4	3	3	4	3
ES4-FO FMS	3	3	1	3	1	3	2	4
ES4-CAPT Nav Pubs	3	3	2	2	2	2	2	2
ES4-FO Nav Pubs	4	3	1	4	2	2	3	3
ES5-CAPT FMS	2	3	3	2	2	1	3	2
ES5-CAPT Decision	3	3	2	2	2	2	2	4
ES5-FO EFB	3	3	2	2	2	2	3	2
ES5-FO ATC Compliance	4	3	2	4	1	2	2	3
Variance	0.38	0.17	0.35	0.89	0.41	0.47	0.42	0.42
Individual Average	3.50	3.06	2.00	2.78	1.94	2.33	2.78	2.78
Group Average	2.65	2.65	2.65	2.65	2.65	2.65	2.65	2.65
TTEST	0.00	0.00	0.00	0.42	0.00	0.07	0.25	0.33
	HIGH	HIGH	LOW	OKAY	LOW	OKAY	OKAY	OKAY

Analyzing AQP Data to Improve EFB Operations and Training, June 2, 2010

Train I/Es: Systematic Differences

For this analysis, examine the data by I/E, looking at the mean and variance in each column to determine whether:

- The Individual I/E ratings are significantly different from the group mean ratings:
 - If **t test** > than **.05**, then I/E is **OK** (I/E not significantly different from Group)
 - If **t test** < than **.05**, determine whether I/E is **HIGH** or **LOW** compared to the Group Mean.

Train I/Es: Systematic Differences

	I/E-1	I/E-2	I/E-3	I/E-4	I/E-5	I/E-6	I/E-7	I/E-8
Variance	0.38	0.17	0.35	0.89	0.41	0.47	0.42	0.42
Individual Mean	3.50	3.06	2.00	2.78	1.94	2.33	2.78	2.78
Group Mean	2.65	2.65	2.65	2.65	2.65	2.65	2.65	2.65
t test Significance	0.00	0.00	0.00	0.42	0.00	0.07	0.25	0.33
	HIGH	HIGH	LOW	OK	LOW	OK	OK	OK

Note: This data was generated to emphasize specific points.

Train I/Es: Agreement

For this analysis, examine the data for each behavior being rated. Analyze the variance in each row to determine whether:

- The specific item had acceptable agreement:
 - If *rwg* is \geq than .6, then agreement is **OK**
 - If *rwg* is $<$ than .5, then agreement should be reviewed
- There is a pattern across the items showing low agreement.

Train I/Es: Agreement ($r_{wg} > .6$ Ok $< .5$ Problem)

EFB I/E Check	I/E-1	I/E-2	I/E-3	I/E-4	I/E-5	I/E-6	I/E-7	I/E-8	AGREE
ES1-CAPT FMS & Brief	4	3	3	4	3	2	4	3	0.60
ES1-FO FMS & Support Brief	4	3	2	3	2	1	3	3	0.33
ES2-CAPT MEL	4	4	3	4	3	3	3	3	0.79
ES2-CAPT Decision	4	3	2	3	2	2	3	3	0.60
ES2-FO MEL	3	2	2	2	1	3	2	2	0.67
ES2-FO Support	3	3	1	2	1	3	2	2	0.44
ES3-CAPT ID J85	3	3	2	1	2	2	3	2	0.60
ES3-FO ID J85	4	3	2	2	2	3	3	3	0.60
ES3-CAPT FMS	4	3	2	3	2	3	3	3	0.67
ES3-FO FMS	4	4	2	3	2	3	3	3	0.54
ES4-CAPT FMS	4	3	2	4	3	3	4	3	0.60
ES4-FO FMS	3	3	1	3	1	3	2	4	0.09
ES4-CAPT Nav Pubs	3	3	2	2	2	2	2	2	0.83
ES4-FO Nav Pubs	4	3	1	4	2	2	3	3	0.14
ES5-CAPT FMS	2	3	3	2	2	1	3	2	0.60
ES5-CAPT Decision	3	3	2	2	2	2	2	4	0.54
ES5-FO EFB	3	3	2	2	2	2	3	2	0.79
ES5-FO ATC Compliance	4	3	2	4	1	2	2	3	0.10

Train I/Es: Standardize Assessment

If I/Es show Systematic Differences or there is lack of Agreement on specific behaviors:

- Work with I/Es as a team to discuss problems
- Review the rating scales and markers as a group
- Review relevant procedures and standards
- Review LOS Event Sets and their assessment
- Form a group consensus on pilot and crew assessment
- Have I/Es rate and review until standardized.

Captain's EFB Display with Chart



Analyzing AQP Data to Improve EFB Operations and Training, June 2, 2010

Conduct EFB Curriculum

Home Study

- Legends and Tables document
- Aircraft Bulletin
- Website Operations
- Review the publications on the website
- *Open book guided evaluation*

Classroom Training

- EFB hardware overview
- Utilization of EFB and contingencies
- Practice
- *Classroom quiz*

Conduct EFB Curriculum

Home Study

Flight Manual Bulletin

Electronic Route Manual Chart Clip



Classroom Training



Conduct EFB Curriculum

Simulator LOS:

- Crew LOS briefing
- Crew flight planning
- Operational Evaluation Simulator LOS
- Crew members complete Workload Rating Form.

Debrief:

- Crew members complete Exit Questionnaire and debriefing.

Conduct EFB Curriculum: Data Collection

For the Small Group Tryout, consider the following:

- Do not start collecting data until I/E assessment of crews is standardized
- Collect data on EFB as well as existing system usage
- Use from 6 to 10 crews for each system evaluated
- Ensure uniform LOS administration and data collection
- Consider collecting situation awareness, head-down time and workload data in addition to crew performance data.

Analyze SGT Data: Variance

Looking at the eight I/Es, based on a Small Group Tryout of 24 LOSs, note that I/E-2 still has a relatively low variance, and a check on the data shows that I/E-2 is still most comfortable giving a rating of 3. Some of the other rater biases persisted, like I/E-1 being higher than the group.

	I/E-1	I/E-2	I/E-3	I/E-4	I/E-5	I/E-6	I/E-7	I/E-8
Variance	0.36	0.15	0.34	0.76	0.39	0.45	0.40	0.40
Individual Mean	3.41	3.00	2.00	2.91	1.94	2.33	2.78	2.78
Group Mean	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64

Note: This data was generated to emphasize specific points.

Improve Rater Reliability

Based on I/E means and variance for the Small Group Tryout data, the following revisions should be considered:

- Review behavioral markers and the use of the 4-point rating scale
- Review the LOS Event Sets with an emphasis on EFB related conditions and triggers
- Provide additional I/E IRR training based on a group review of Small Group Tryout data.

Review Means Across All LOSs

ES1-CAPT FMS & Brief	3.2
ES1-FO FMS & Support Brief	2.4
ES2-CAPT MEL	3.3
ES2-CAPT Decision	2.8
ES2-FO MEL	2.6
ES2-FO Support	2.6
ES3-CAPT ID J85	2.3
ES3-FO ID J85	2.4
ES3-CAPT FMS	2.8
ES3-FO FMS	2.4
ES4-CAPT FMS	3.3
ES4-FO FMS	2.4
ES4-CAPT Nav Pubs	2.6
ES4-FO Nav Pubs	2.7
ES5-CAPT FMS	2.6
ES5-CAPT Decision	2.5
ES5-FO EFB	2.4
ES5-FO ATC Compliance	2.6

Note: This data was generated to emphasize specific points.

Revise Procedures and Training

Based on the overall crew performance Means of the Small Group Tryout, consider:

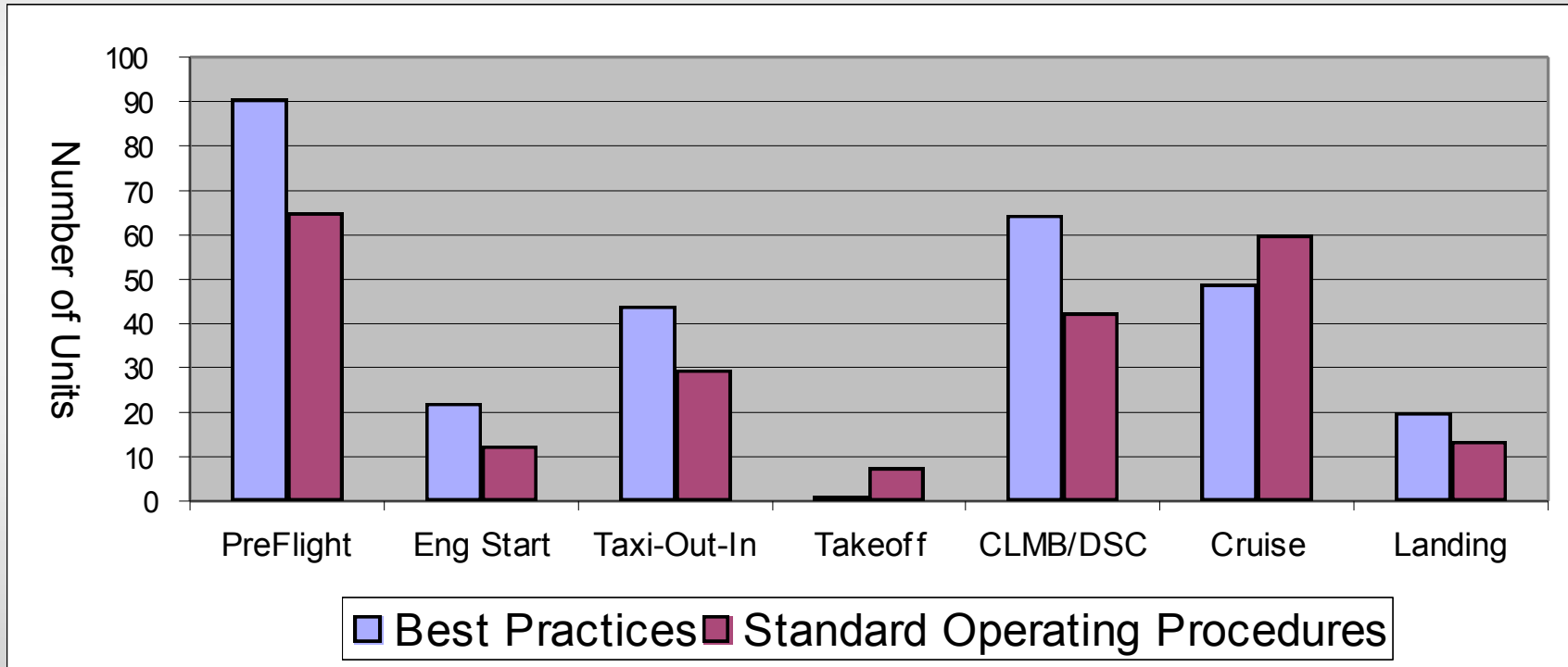
- Reviewing and refining FO procedures, especially in the area of FMS data entry, crosschecking and monitoring
- Identifying best practices of top performing crews
- Refining the EFB training by adding best practices and showing how to use the EFB to crosscheck FMS data
- Refining EFB training in the area of crew coordination and workload management.

EFB Training and Best Practices

Sample EFB workload management best practices include:

- Using the EFB Load Setup function during Preflight to reduce workload
- Using the EFB Send function in ways to reduce crew workload
- Setting up the approach charts and documents during times of low workload
- Using the EFB Print function in preparation for periods of heavier workload.

Subject Matter Expert Comments

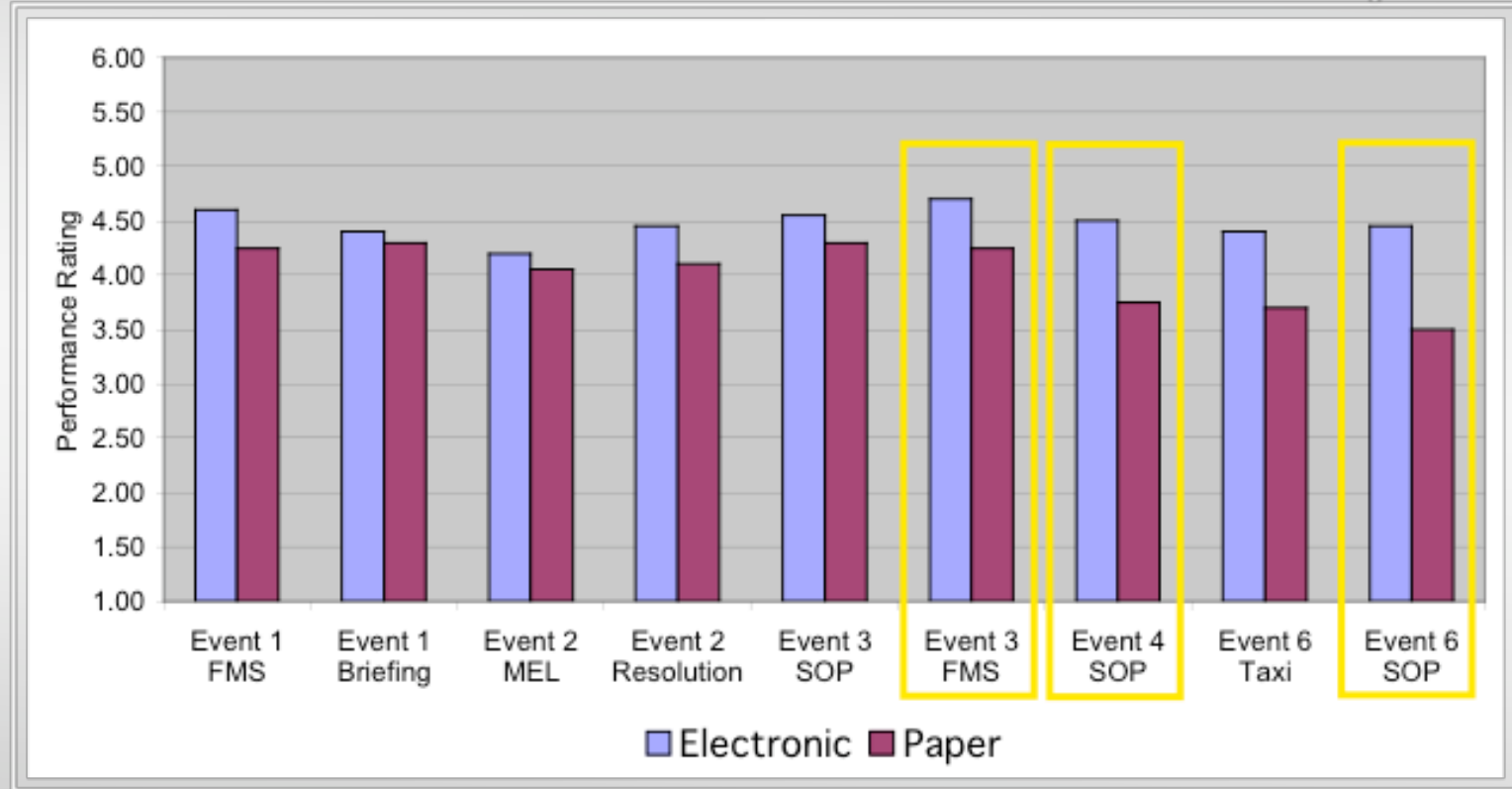


Longitudinal Data Analysis

Successful longitudinal data analysis includes:

- Initiating data collection and analysis early in the implementation process
- Using a de-identified system to better analyze longitudinal data
- Using longitudinal I/E data to improve their standardization
- Identifying above average pilots and crews and use their performance to specify best practices
- Identifying problems before they become significant issues
- **Using similar Event Sets to evaluate crew performance using EFB compared with them using the old system.**

Crew Performance with EFB & Paper



• *Yellow boxes indicate significant differences $< .05$*

Beyond the EFB

The AQP structure and methods can be applied to the implementation of a number of flightdeck technologies under NextGen such as:

- Controller-Pilot Data Link Communications (CPDLC)
- Cockpit Display of Traffic Information (CDTI)
- Automatic Dependent Surveillance-Broadcast.

Key Points

- Initiate data collection and analysis early in the implementation process
- Use data to identify procedural and training refinements
- Use a de-identified system to analyze longitudinal data
- Use longitudinal I/E data to improve their standardization.
- Identify above average pilots and crews and use their performance to specify best practices
- Analyze below average crew performance data to isolate problems with the training, evaluator standardization and pilot proficiency.

Thank You

For Questions:

Barbara Kanki

barbara.g.kanki@nasa.gov

Thomas Seamster

tseamster@qwest.net